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The Real Impact of Financial Shocks

Evidence from the Republic of Korea

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Giovanni Ferri

To what extent did tightening monetary policy magnify the East Asian crisis through its adverse effects on credit supply?

In the Republic of Korea, interest rate spreads, which capture credit channel effects, influence economic activity, and these effects are disproportionately larger for small and medium-size enterprises. So policymakers who neglect credit channel effects might be "overkilling the economy" and altogether overlooking the disproportionate effects of monetary and financial shocks on some sectors.

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Summary findings

The debates surrounding the recent East Asian crisis have focused not only on causes but also on policy actions in the wake of the initial shock. This has raised questions about the relationship between monetary policy and market confidence. Specifically, would rising interest rates bolster or depress market confidence? To answer this question requires assessing whether, and to what extent, monetary and financial shocks are magnified through the economy via the credit channel.

Domaç and Ferri focus on the Republic of Korea — a particularly good case for testing credit channel effects — with two objectives:

- To ascertain whether and to what extent interest rate spreads could help predict subsequent fluctuations in real economic activity.
- To test whether small and medium-size enterprises suffer more than other businesses do from the adverse effects of the credit channel.

The authors'empirical findings support the hypothesis that spreads that capture credit channel effects do indeed influence economic activity. Specifically, spreads contain significant information for predicting the future course of industrial production. The effect is, as one might have assumed, disproportionately larger for small and medium-size enterprises. Thus policymakers, in Korea and elsewhere, who neglect credit channel effects might be "overkilling the economy" and altogether overlooking the disproportionate effects of monetary and financial shocks on various segments of the economy.

This paper — a product of the Poverty Reduction and Economic Management Sector Unit and the Financial Sector Development Sector Unit, East Asia and Pacific Region — is part of a larger effort in the region to analyze the patterns and consequences of the East Asian crisis, with particular reference to the link between the real and financial sectors. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Muriel Greaves, room MC8-150, telephone 202-458-1876, fax 202-522-1784, Internet address mgreaves@worldbank.org. The authors may be contacted at idomac@worldbank.org or gferri@worldbank.org. November 1998. (32 pages)

The Real Impact of Financial Shocks: Evidence from Korea

by

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1. INTRODUCTION

The East Asian crisis has stimulated an intensive debate, not only on the causes, but on the policy actions that have been adopted in response to the initial shock. The question perhaps at the center of the most vehement dispute is: to what extent can tight monetary policy help restore market confidence? Many economists have acknowledged that monetary restriction was necessary to achieve stabilization in the crisis countries. Some, however, have argued that under the prevailing circumstances, rising real interest rates might fail to bolster market confidence and thus prove counter-productive.[1] Indeed, some features of the East Asian economies, i.e. bank-based financial systems and high leverage, appear particularly conducive to a significant credit channel of transmission of monetary/financial shocks. The magnifying effects stemming from this channel render these economies particularly vulnerable to monetary/financial shocks.

While some have already provided preliminary evidence that credit channel effects may have triggered a credit crunch in East Asia,[2] relatively little work has been done trying to assess the magnitude of the impact. In this paper, we focus on South Korea (henceforth Korea) in an attempt to perform such an assessment. We focus on Korea mainly for three reasons. First, Korea is the most developed among the five East Asian crisis countries, namely, *Indonesia*, *Korea*, *Malaysia*, *the Philippines*, and *Thailand*. Among these countries, Korea probably enjoys the most developed financial

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1 For instance. Feldstein (1998) claims that high real interest rates caused more harm than good by leading to widespread bankruptcies. thus undermining the prospect of loan repayment.

2 See. for example. Ding. Domaç. and Ferri (1998).

markets where corporations can issue sizable amounts of both bonds and commercial paper. As such, were we to find strong lending channel effects for Korea, there would be a strong presupposition that analogous effects could possibly apply to the other crisis countries. Second, the intensity of monetary restriction in Korea was by most measures the highest, thus making it the best candidate to identify the propagation of the monetary shock through the credit channel. Third, some of the relevant data necessary to test our hypotheses were promptly available for Korea but not for the other crisis countries.

Analyzing the relationship between some specific interest rate spreads capturing credit channel effects and industrial production constitutes the crux of our investigation. More specifically, we perform various statistical tests to assess the direction of causality between the spreads and industrial production. We also make an attempt to quantify the impact of the credit channel variables on industrial production. Furthermore, we test the commonly held hypothesis that small and medium-sized enterprises (SMEs) suffer disproportionately from the adverse consequences of the credit channel. To this end, we contrast the results obtained for the overall index of industrial production with those obtained for the index of industrial production of SMEs.

The empirical results underscore that causality clearly runs from the spreads capturing credit channel effects to production; the causality is stronger for SMEs' production than it is for overall production. Regarding the size of the impact, we find that a 1 percentage point increase in the spread between bank lending rate and Government bond rate is associated with a decline of 1.4 percent in overall industrial production and a decline of 1.7 percent in SMEs' industrial production. Considering that this spread has increased by at least 5 percentage points after the initial shock and the inception of the restrictive monetary policy, this could imply a drop of around 7 percent for overall industrial production and somewhere between 8 and 9 percent for SMEs' industrial production.

The rest of the paper is organized as follows. Section 2 presents a non-technical exposition of our approach to identify credit channel effects. Section 3 briefly describes the developments leading to a credit crunch in the aftermath of the crisis in Korea. Section 4 presents the empirical framework and the results. Section 5 concludes the paper.

2. A NON-TECHNICAL EXPOSITION OF THE APPROACH

2.1 The Framework

Our approach is inspired by the method that we find most convincing, namely, relying on the spread between bank lending rates and a set of market interest rates on various other risk-free and risk-bearing assets. The conjecture we follow is rather simple (see Bernanke and Blinder, 1988). A decline in either bank loans or a decline in their growth following a monetary tightening is not sufficient to pin down an adverse movement in banks' loan supply. This is because the decline could be induced either by the corporate sector demanding less credit -- because fewer investments are undertaken -- or by the banks' reluctance to lend. By contrast, if the decline in (the dynamics of) bank loans is coupled with a widening of the spread between bank lending rates and the rates prevailing on analogous non-bank debt market instruments, then it can be argued that an adverse shift in the banks' supply of loans is curtailing credit. In fact, such a situation is consistent with only two possibilities: either supply has declined whereas demand has not, or supply has declined more than demand.

Furthermore, we follow the widely held recommendation (Bernanke and Gertler, 1995; Hubbard, 1995) to split the credit channel impact into two separate components: the balance sheet effect and the lending channel effect.

The balance sheet effect emphasizes the potential depressing impact of the monetary squeeze on borrowers' assets and profits, by affecting variables such as borrowers' net worth, cash flow and liquid assets, which increases the risk premium. The increase in the level of interest rates triggered by the monetary squeeze raises corporate risks because it reduces both business profits and the value of assets that firms have posted as collateral. This will generally increase the wedge between the interest rates at which corporates can borrow and the yields on otherwise analogous risk-free assets.

By contrast, the bank lending channel effect focuses on the retrenchment in the supply of loans by depository institutions in the wake of the monetary restriction. Specifically, the chain of actions runs as follows. The monetary squeeze raises the level of interest rates even for risk-free assets such as T-bills and Government bonds. In general, banks cannot increase deposit rates by as much since they have to build required reserves which either bear no-remuneration or offer a below-market yield. This means that banks suffer a deposit drain as investors reshuffle their portfolios away from deposits and towards assets with more attractive yields. Banks are not indifferent between making loans to the private sector and holding Government securities -- i.e. Government securities provide a cost efficient way to carry a secondary liquidity cushion, and banks may be unwilling to deplete their holding of such securities below some threshold. Accordingly, following the deposit drain, they will probably enact a restriction in their loan supply. If all firms were indifferent between borrowing at banks and issuing debt on the market, this would not imply that bank lending rates should increase more than corporate debt market rates. In reality, however, we know that the majority of businesses do not issue debt on the market. Consequently, after the monetary tightening we can expect that the wedge between bank lending rates and corporate debt market rates may also increase.[3]

Finally, we rely on previous studies built on the hypothesis that credit channel effects are likely to be most important for those firms which, being unable to issue debt on the market, could be classified as bank-dependent borrowers. This suggests that the credit channel is likely to particularly penalize the small and medium-sized enterprises (SMEs),[4] most of which are *de facto* bank-dependent borrowers.[5] An additional reason for SMEs being disproportionately affected by credit channel effects derives from the possibility that the monetary squeeze triggers a flight to quality in bank lending. More specifically, banks may respond to the monetary restriction, not only restraining credit generally, but also by adopting more stringent lending policies vis-à-vis customers that

3 A similar impact could be induced by the introduction of stricter regulations on banks: e.g. the imposition of higher capital adequacy ratios (Bernanke and Lown (1992)).

4 Gertler and Gilchrist (1994) show evidence consistent with this hypothesis.

5 In the first place. SMEs are too small to justify the fixed costs entailed by listing securities. In addition, even when they have the intention of issuing debt on the market, they will most likely refrain from doing so. Because of the low liquidity of their debt. investors would ask for very high yields, thus making issuance unattractive.

are perceived to be less credit worthy.[6] That is, when a deposit drain squeezes their resources, banks will try to cherry-pick customers who are *ex ante* more credit-worthy: e.g. those having a more established credit record or those able to post more collateral.[7] In turn, as stressed by Bernanke, Gertler, and Gilchrist (1996), the flight to quality in bank lending may trigger a financial accelerator effect along the following causal chain: the negative shock precipitates the economy into a recession; the recession makes borrowing constraints tighter; tighter borrowing constraints amplify the recession, and so on.[8]

A final ingredient that suggests SMEs are more penalized by the credit channel derives from the possibility that when a financial crisis ensues, depositors may also enact a flight to quality (safety). Envisaging increased bank fragility, depositors may shift their savings towards institutions that are perceived to be less likely to go bankrupt. To the extent that the smaller banks are seen as less likely to be bailed out by the Government, they may be the ones to suffer most in the deposit flight. Thus, it is likely that the institutions which receive new flows of funds have no established relationship with the borrowers of those institutions losing resources. Accordingly, the institutions receiving new flows are not likely to make loans to those borrowers. In this case, an additional

6 Bernanke, Gertler and Gilchrist (1996) report evidence consistent with this hypothesis. A negative bias similar to that regarding SMEs might apply to fast-growing firms, since they have a higher ratio of expected future profits to the current value of physical assets and thus can provide lower collateral.

7 Lenders perceive SMEs to be more risky since they generally have a shorter track record and typically release less --and less structured-- information.

8 A model deploying financial accelerator effects was proposed by Kyiotaki and Moore (1997). Lang and Nakamura (1995) report evidence of a flight to quality in bank lending within the US.

credit squeeze may hit those customers borrowing from smaller banks,[9] and SMEs, more than other firms, typically depend on small banks' lending.[10]

The relationship between bank lending rate spreads and productive activity has been widely studied in the tradition of the credit channel. Referring to the US, several studies provide convincing empirical evidence on the importance of the above mentioned interest rate spreads. Kashyap, Stein, and Wilcox (1993) show that, in general, tight monetary conditions bring about a widening in the spread between commercial paper rate and T-bill rate; Gertler, Hubbard, and Kashyap (1991), as well as Friedman and Kuttner (1998) document that an increase in the spread is a good predictor of a subsequent decline in investment and real output.

Nonetheless, analyzing the relationship between interest rate spreads and productive activity is however not exclusive to the literature on the credit channel. For instance, Stock and Watson (1989) include two interest rate spreads in their well known composite leading indicator: the spread between commercial paper and Treasury bills with 6-month maturity at issue on one hand and the yield spread between 10-year and 1-year Treasury bonds on the other. Moreover, Estrella and Mishkin (1998) show that the slope of the yield curve -- as measured by the difference between 10-year Treasury bonds and 3-month Treasury bills -- has proved the out-of-sample predictor of recessions in the USA over the years 1971-1995 among a set comprising various monetary/financial variables, some macro-indicators and various leading indicators.

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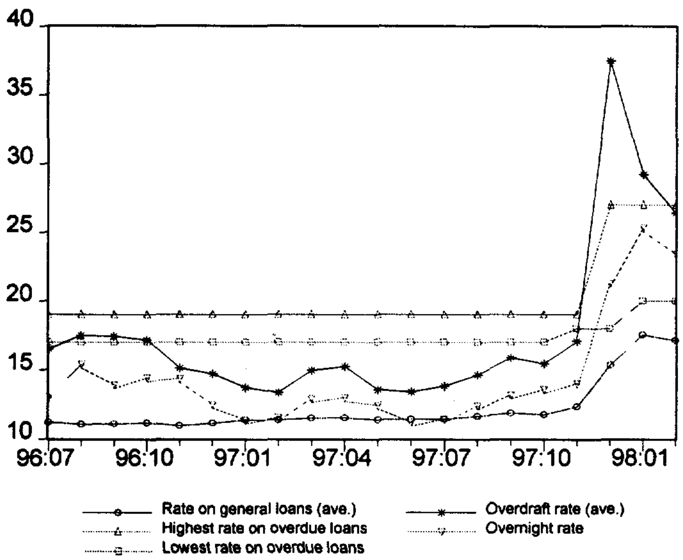
9 Kashyap and Stein (1994. 1997) argue that small banks. rather than large ones. are more likely to be hit by monetary restrictions.

2.2 The Meaning of the Various Interest Rate Spreads

The objective of our analytical framework is twofold. First, we want to assess the overall impact attributable to credit channel effects. Second, we wish to decompose this impact into its two parts: the balance sheet effect and the lending channel effect. In pursuing the latter objective, we also make an attempt to appraise the lessons learned on the link between the yield curve and production.

Figure 1. Evolution of Various Interest Rates



In order to assess the impact attributable to credit channel effects, in line with the literature, we take the spread between marginal bank lending rates and Treasury bonds as representative of the overall impact of the credit channel.[11] Our first choice was which

10 Berger, Kashyap and Scalise (1995) document a strong correlation between relative size of the lending bank and relative size of the borrowing firm in the US: i.e. small firms tend to borrow from small banks and large firms to borrow from large banks. Angeloni et al (1995) present analogous evidence for Italy.

11 Before focusing on the sole spread, we have checked that the spread -- as well as its two major components that we will introduce shortly -- tends to increase in conjunction with either a decrease or a deceleration in lending,

bank lending rate to select among the three rates available. In particular, we could select either the rate on general loans, the rate on overdraft loans, or the (lowest and highest) rate on loans overdue. Figure 1 illustrates, over the relevant period, the relationship between the three lending rates, and the overnight rate, supposedly determined by monetary policy actions and representing the cost at which banks can raise funds on the interbank market.[12]

It is easy to see that both the rate on general loans and that (lowest and highest) on loans overdue are quite sticky relative to the overnight rate, whereas the overdraft rate proves much more responsive. Such stickiness stems from banks' rate setting which does not fully reflect market conditions and, as such, might not be fully indicative of the terms at which new loans may be obtained by businesses -- especially considering that lending rate stickiness could be associated with larger quantity rationing of loans. [13] This is the main reason why we decided to adopt the overdraft rate which seems to be the only one of the three to promptly reflect changes in banks' cost of funds.[14] Given the typically

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thus solving the identification problem described above. Indeed, the correlation coefficient over the period 1992.01-1998.02 between spreads, namely SPR0, SPR1, SPR2, and SPR3 and changes in real loans is respectively -0.49, -0.51, -0.35, and -0.29.

12 Figure 1 starts from 1996.07, the first month for which data on the actual average lending rate (both the overdraft and the general loan) are available. Before 1996.07, two rates (both for overdraft and general loan) were published: the highest and the lowest. In the empirical part of this paper, we obviously need to use a longer series of the overdraft rate that we select. At first, we considered constructing the average overdraft rate for the period 1992.01 - 1996.06 by taking the mid-point between the highest and the lowest overdraft rates. However, for the period (1996.07 - 1997:03) over which we could observe all three rates (actual average overdraft, highest and lowest overdraft), we detected that the mid-point criterion would result in a grossly unsatisfactory estimate of the actual average overdraft rate, without a systematic bias. Therefore, we had to adopt a different strategy. To this end, we estimated the actual average overdraft rate as a function of the money market rate over the period 1996.07-1998.02, and found that the latter explains almost 80 percent of the variability in the former. We then used the estimated relationship to construct the average overdraft lending rate for the missing period.

13 Stiglitz and Weiss (1981) show that banks may refrain from raising lending rates and rely more on credit rationing due to asymmetric information and the resulting adverse selection problem.

14 To the extent that we want to take a lending rate which is representative of the condition at the margin, the fact that overdraft loans constitute only 5 to 6 percent of total loans at Korean banks has little consequence for us.

short maturity of overdraft loans, it would be desirable to measure the spread between the lending rate and T-bill rates, this, however, turns out to be impossible since issues of T-bills in Korea were scant over our period of analysis.

Concerning the decomposition of the overall credit channel effect into its two parts, we measure the spread indicative of the balance sheet effect as the difference between rates on corporate bonds and rates on Treasury bonds. The proxy for the lending channel effect is given by the spread between the lending rate and the rate on 6-month commercial paper. The rationale for selecting these two spreads is simple. First, the difference between rates on corporate and on Treasury bonds measures the general risk premium as it is perceived by the market. If the balance sheet effect is at work, we expect that this spread will increase after the monetary restriction, reflecting the fact that private sector debt has become relatively riskier vis-à-vis sovereign debt. Second, the difference between lending rates and commercial paper rates quantifies the premium that bank-dependent borrowers must pay in order to raise external finance relative to those firms able to issue debt on the market. The lending channel effect postulates that this spread will increase in the aftermath of the monetary squeeze, for the reasons discussed above. To be sure, the decomposition of the difference between the lending rate and the Treasury bond rate into the rate spread between corporate and Treasury bonds on one hand and the rate spread between loans and commercial paper on the other, predicates the existence of a third component. This last component is given by the spread between corporate bond rate and commercial paper rate. Considering that overlap is likely between those firms issuing bonds and those issuing commercial paper, we can assume that this third spread proxies for the slope of the yield curve. In fact, corporate bonds typically have a maturity at issue of 36 months compared with 6 months for commercial paper.[15]

All in all, the set of interest rate spreads can easily be grasped from the following expression:

$$SPR0 = LR - TB = SPR1 + SPR2 + SPR3 \tag{1}$$

where

LR = lending rate;
TB = Treasury bond rate;
SPR1 = corporate bond rate - Treasury bond rate;
SPR2 = lending rate - commercial paper rate;
SPR3 = commercial paper rate - corporate bond rate.

The expected impact of the three spreads on industrial production is negative, since the first and the second reflect the adverse impact of the balance sheet effect and the lending channel effect, whereas an increase in the third spread is likely to be associated with a subsequent downturn in economic activity.

15 Since Treasury bonds typically have a maturity at issue of 60 months, strictly speaking, the first spread does not provide a fully accurate measure of the general risk premium of private debt versus Treasury debt but incorporates also a term structure component. Given that we could observe neither a 60-month corporate bond yield nor a 36-month Treasury bond yield, it was impossible for us to unbundle the two components in the first spread. It is well known, however, that yield curve spreads tend to be more meaningful at relatively shorter maturities than at longer ones: this is certainly the case if mean reversion applies (Cox et al., 1985).

3. THE CREDIT CHANNEL IS AT WORK IN THE AFTERMATH OF THE CRISIS

A large build-up of industrial capacity made Korea highly vulnerable to the slowing of its economy in 1996 and 1997. The fact that growth of productive capacity had been financed largely with bank credit meant that the vulnerability to an economic slowdown also extended to the financial sector. In the face of the adverse consequences of the crisis, this vulnerability has indeed proven to be more serious than had been earlier anticipated: Korea experienced a sharp decline in industrial production at the end of 1997 and an even sharper decline in the beginning of 1998 (Figure 2 and Figure 3).

Figure 2
Index of Overall Industrial Production

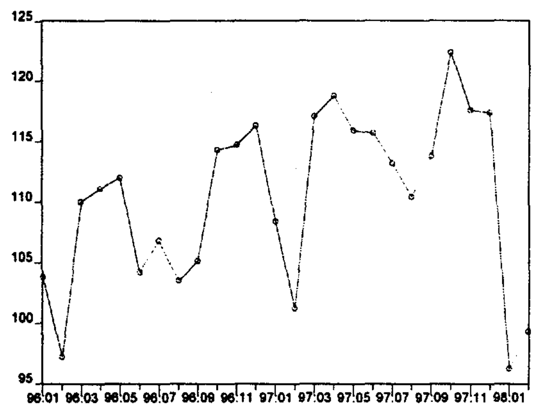
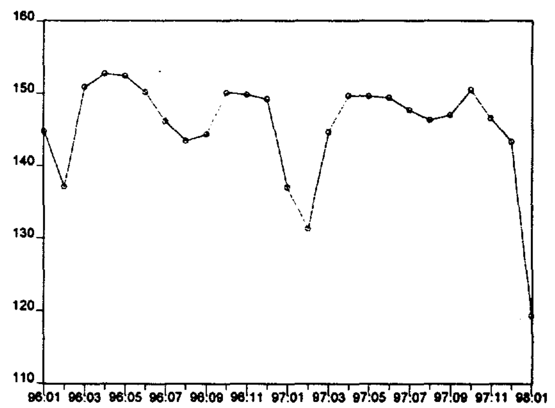


Figure 3
Index of SMEs' Industrial Production



Macroeconomic policies were tightened noticeably and far-reaching structural adjustment measures were proposed in late 1997 and early 1998. In order to combat the inflationary pressures arising from currency depreciation and to restore the credibility of its foreign exchange and financial markets, the Central Bank liberalized and raised interest rates in January 1998. The overnight rate peaked at 25 percent in January 1998, from 11 percent a year before. In the meantime, banks reportedly became reluctant to lend and started calling in loans that would have been rolled over in different circumstances.

An examination of both the growth rate of real loans (Figure 4), and money market rate along with inflation (Figure 5) underscores the tight monetary conditions. As previously suggested, this evidence alone is insufficient to conclude that there is a "credit crunch" in Korea. Nevertheless, such a conclusion can be drawn if we add the observation that all the spreads measuring the credit channel effect have widened (Figure 6). In particular, a sharp increase in the risk premium on corporate debt is captured by the rising yield differential between corporate and Government bonds, measuring the balance sheet effect. From about 100 basis points until October 1997 this spread increased to 197 b.p. in November 1997; it reached 899 b.p. in the following month at the peak of the crisis and declined relatively thereafter. The lending channel effect is also at work: the spread between the overdraft lending rate and the yield on commercial paper increased markedly since September, reached 13.2 percentage points in December 1997, and remained close to 6 percentage points during the first two months of 1998.

Figure 4
Growth Rate of Real Loans

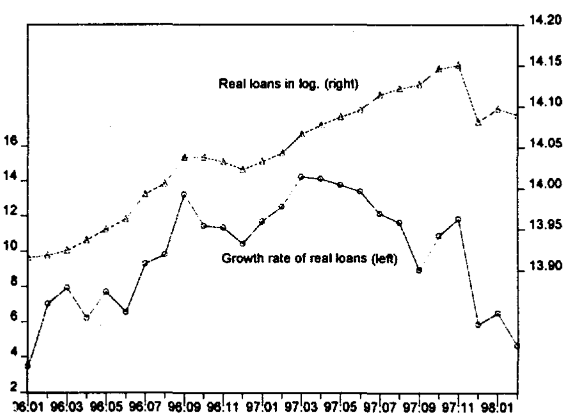


Figure 5
Money Market Rate and Inflation

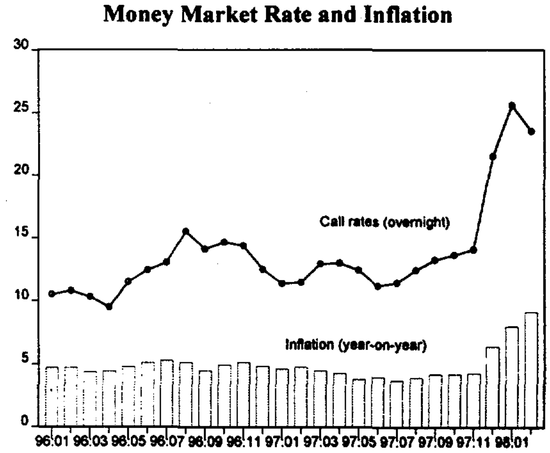
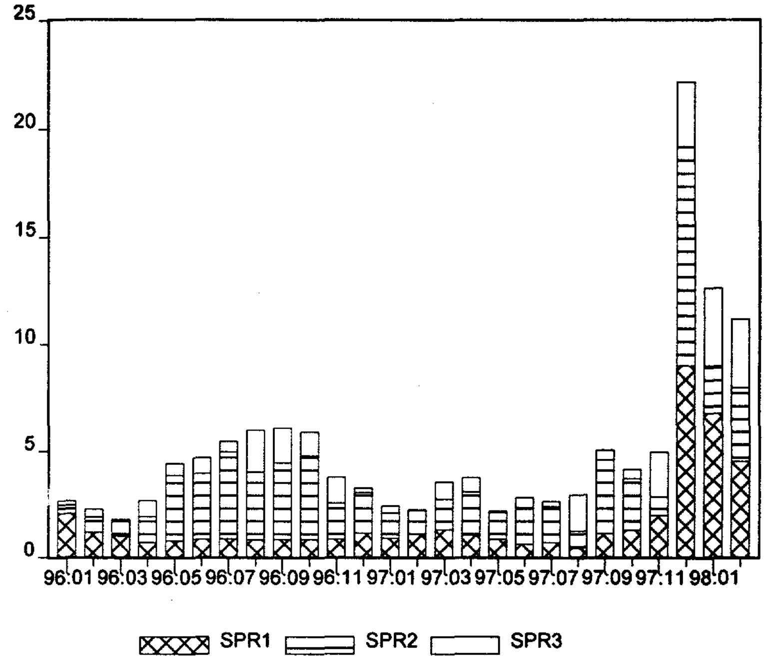


Figure 6
Evolution of the Spreads



All in all, the evidence supports the existence of a credit crunch in Korea. There are clear indications that the credit crunch has been operating through both the balance sheet and lending channel effects.

4. THE EMPIRICAL FRAMEWORK AND THE MAIN RESULTS [16]

The objective of our empirical framework is twofold: (i) investigating the causal relationship between the relevant spreads and industrial production, both overall and for the SMEs; and (ii) examining the quantitative impact of an increase in the relevant spreads on industrial production, again both overall and for the SMEs. The first

[16] The index of industrial production for SMEs is that computed by the Industrial Bank of Korea and published in the monthly bulletin of the Bank of Korea. All the other data are obtained from the website of the Bank of Korea over the period 1992.01-1998.02.

investigation will reveal whether prior movements of the spreads influence the development of industrial production. The second investigation helps show whether SMEs are, indeed, disproportionately hurt by an increase in the relevant spreads due, for example, to tightening in monetary policy stance or other factors.

4.1 The Direction of Causality between the Spreads and Industrial Production

Several studies have investigated the information content of spreads with respect to subsequent fluctuations in real economic activity, but have done so mainly for the largest industrialized countries.[17] We follow the standard empirical exercises employed in earlier studies, *Granger causality tests*, to examine whether the relevant spreads convey information about economic activity (industrial production) in Korea. This technique helps identify variables that embody significant information for predicting the future course of industrial production and this, in turn, will provide valuable guidance for policy makers in designing economic policies.

We regress changes in industrial production on both past values of itself and past values of the relevant spreads. If the spread under examination is statistically significant in this regression, then it furnishes information about future industrial production over and above that provided by past values of industrial production. This involves a series of bi-variate Granger causality tests, where the estimated equations are of the form:

17 See for example Friedman and Kuttner (1998) as well as Browne and Tease (1992).

$$\Delta Y_t = \eta + \sum_{i=1}^{m} \delta_i \Delta Y_{t-i} + \sum_{i=1}^{m} \mu_i SPR_{t-i} + \upsilon_t \qquad (2)$$

Y (Y^{SME}) represents the overall (SMEs) industrial production. As an alternative we also used the deviation of industrial production from its trend ($Y-Y^T$) for both the overall and SMEs' industrial production.[18] SPR is an element in the set of indicator variables, which for this exercise includes SPR0 (overdraft lending rate-Government bond rate), SPR1 (corporate bond rate-Government bond rate), SPR2 (overdraft lending rate-commercial paper rate), and SPR3 (commercial paper rate-corporate bond rate).

In the sample, we use monthly data from January 1992 to February 1998. After investigating the time series properties of the variables involved and ascertaining that all variables are stationary and integrated same order,[19] we compute F-tests for the null hypothesis of the non-Granger causality of the relevant indicator variable and calculate the marginal significance levels (p-values) for the bi-variate Granger causality tests for lag lengths of 1 to 12. The smaller these values, the stronger the predictive content of the relevant indicator for the particular measure of industrial production. Therefore, the test results will also shed light on the issue of whether the predictive power of the these spreads is different for the SMEs' industrial production.

The tables in the Appendix present the overall results of this exercise. The empirical evidence is fairly convincing that the spreads of interest are a *prima facie* cause of industrial production, both overall and for the SMEs. There is no evidence that

18 The trend is computed by using the Hodrick and Prescot (HP) filter.

industrial production is a *prima facie* cause of the spreads considered in our investigation. The empirical findings from bi-variate causality tests suggest that prior movements of the spreads influence the development of industrial production. An interesting observation is that the predictive content of the spreads is higher (i.e., smaller p-values) for the SMEs' industrial production. This is consistent with the argument that an increase in the spreads will disproportionately hurt SMEs, for whom close substitutes for bank credit are unavailable.

In an attempt to examine the robustness of our bi-variate causality test results, we include an important policy variable, the overnight interest rate, into equation (2) to find out whether the spreads retain their predictive power even in the presence of a variable capturing the stance of monetary policy. This is important since the influence of the spreads on industrial production may be due to their response to changes in monetary policy. We estimate the following equation:

$$\Delta Y_t = \eta + \sum_{i=1}^{m} \delta_i \Delta Y_{t-i} + \sum_{i=1}^{m} \mu_i SPR_{t-i} + \sum_{i=1}^{m} \varphi_i \Delta r_{t-i} + \varepsilon_t \quad (3)$$

where r is a short-term interest rate which reflects the stance of monetary policy. Once again, if the spreads have no predictive power, their coefficients will be zero.

Tables 1A to 2B present the results of this exercise. The empirical findings show that SPR1 and SPR3 are no longer useful predictors of overall industrial production in the

19 Although the results of the Phillips Perron test including trend indicate that the overall industrial production is stationary, further inspection of autocorrelations and partial autocorrelations of this variable suggests that it is integrated order of one, I(1).

presence of the overnight rate. This suggests that part of the predictive power of SPR1 and SPR3 for the overall industrial production reflects the stance of monetary policy. In the case of the SMEs' industrial production, however, SPR1 also maintains its strong predictive power. As was the case with the bi-variate causality tests, the predictive content of the spreads for SMEs' industrial production remains much higher.

Table 1A. The Results of the Granger Causality Tests in the Presence of Δr

Lags	SPR0 → $(Y-Y^T)$	SPR1 → $(Y-Y^T)$	SPR2 → $(Y-Y^T)$	SPR3 → $(Y-Y^T)$
3	0.106056	0.564291	0.133273	0.172182
6	0.079240	0.512372	0.811497	0.437415
9	0.151473	0.266468	0.842098	0.468537
12	0.600423	0.542472	0.924405	0.974612

Note:*The numbers in the tables are marginal significance level (p-values) of F Tests for the null of non-Granger causality of the variable in question.*

Table 1B. The Results of the Granger Causality Tests for SMEs in the Presence of Δr

Lags	SPR0 → $(Y^{SME}-Y^T)$	SPR1 → $(Y^{SME}-Y^T)$	SPR2 → $(Y^{SME}-Y^T)$	SPR3 → $(Y^{SME}-Y^T)$
3	0.000076	0.002003	0.012310	0.406410
6	0.000124	0.010026	0.142250	0.320106
9	0.004817	0.046813	0.285761	0.482191
12	0.109830	0.026956	0.479630	0.919193

Table 2A. Results of the Granger Causality Tests in the Presence of Δr

Lags	SPR0 → ΔY	SPR1 → ΔY	SPR2 → ΔY	SPR3 → ΔY
3	0.018030	0.245482	0.047421	0.129888
6	0.006957	0.122215	0.765385	0.344299
9	0.217027	0.148178	0.825930	0.897187
12	0.006957	0.613610	0.871602	0.943174

Table 2B. Results of the Granger Causality for SMEs in the Presence of Δr

Lags	SPR0 → ΔY^{SME}	SPR1 → ΔY^{SME}	SPR2 → ΔY^{SME}	SPR3 → ΔY^{SME}
3	0.000058	0.006616	0.031598	0.337026
6	0.000010	0.009168	0.461780	0.195091
9	0.002173	0.015074	0.474381	0.505333
12	0.135815	0.122086	0.831186	0.732602

4.2 The Impact of the Spreads on the Overall and the SMEs' Industrial Production

Although our findings established that the evolution of the relevant spreads are significant for predicting industrial production, particularly in the case of the SMEs' industrial production, they do not reveal any information in terms of the quantitative impact of the spreads on both the overall and the SMEs' industrial production. The estimation of an equation such as (3) for the purpose of identifying the impact of each spread on economic activity requires special attention. This is because the high correlations between SPR and its lagged values would have a detrimental effect on the standard errors of the estimated coefficients, μ_i. As a matter of fact, a distributed lag model has rarely been posited and estimated in as general a form as that specified in (3).

A general strategy for tackling this problem, and its associated imprecision, is to reduce the number of parameters to be estimated by assuming some pattern for the μs. To this end, we rely on an Almon lag scheme which provides a fairly flexible method for reduced parameterization.[20] We impose an Almon lag structure with no constraints on the spread variable, SPR, and estimate equation (3) using monthly data covering the period of 1992.01 -1998.02.[21]

Before presenting the empirical results, several explanations regarding the estimation procedure are in order. First, we have to choose a strategy for determining the degree and the lag length of the polynomial. Since we use monthly data, we choose the

20 See Almon (1962) for more on this.

21 We include seasonal dummies in each estimation.

lag length 12. Next, once the lag length is specified, following Anderson (1971) we consider the highest-degree polynomial possible (seven in our case) and then go backwards, until one of the hypotheses is rejected.[22] As far as the selection of the lag length for ΔY and Δr is considered, we rely on Hendry's General-to-specific-Modeling strategy.[23] We include 12 lags on each term and eliminate the lags whose coefficients are not statistically significant. Finally, we obtain the long-run or equilibrium effects of the relevant spreads from the estimates yielded by equation (3) as the sum of the lag coefficients (e.g., $\sum\mu_i$). [24]

The empirical results are reported in tables 3-6. In each case, we examine the residuals of estimated regressions carefully to make sure that they are white noise. Further, we also check stability of the estimated regressions using the CUSUM test due to Brown, Durbin, and Evans (1975). The results indicate that the estimated regressions are stable over the period studied, thus confirming the structural stability of the models.

Figure 7 contrasts the effects of each spread at different lag length on industrial production, both overall and for the SMEs.

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22 Indeed, without choosing the lag length, it is quite difficult to determine the appropriate degree of the polynomial. As an additional exercises, we employed Ramsey RESET test as suggested by Harper (1977) to test both the degree and order of the Almon polynomial lag used for SPR in our benchmark specifications against a number of alternative patterns for SPR. The results failed to reject our benchmark specifications.

23 See Gilbert (1986) for more on this.

24 It should be noted that the sum of the estimated coefficients on the distributed lag has the interpretation of the long run effect of SPR on industrial production only if all variables involved are stationary.

Table 3. Lag Distribution of SPR0

Lag Distribution of SPR0 (for overall industrial production)				*Lag Distribution of SPR0 (for SMEs)*			
Lags	**Coefficient**	**Std. Error**	**T-Stat**	**Lags**	**Coefficient**	**Std. Error**	**T-Stat**
0	-0.0040	0.0012	-3.4945	0	-0.0033	0.0009	-3.7124
1	-0.0037	0.0008	-4.9267	1	-0.0024	0.0005	-4.7460
2	-0.0025	0.0009	-2.7676	2	-0.0020	0.0007	-2.9516
3	-0.0010	0.0008	-1.2608	3	-0.0018	0.0006	-2.8477
4	0.0004	0.0007	0.5004	4	-0.0015	0.0006	-2.6181
5	0.0011	0.0008	1.3307	5	-0.0011	0.0006	-1.7232
6	0.0012	0.0009	1.3434	6	-0.0005	0.0006	-0.7200
7	0.0006	0.0008	0.7414	7	0.0002	0.0006	0.3922
8	-0.0005	0.0008	-0.6094	8	0.0008	0.0006	1.3653
9	-0.0017	0.0010	-1.6724	9	0.0009	0.0007	1.3240
10	-0.0024	0.0011	-2.1628	10	0.0003	0.0008	0.3931
11	-0.0020	0.0011	-1.8710	11	-0.0016	0.0008	-1.9976
12	0.0004	0.0025	0.1614	12	-0.0053	0.0017	-3.0380
Sum of lags	*-0.0141*	*0.0048*	*-2.9528*	*Sum of lags*	*-0.0171*	*0.0037*	*-4.6457*
Summary Statistics				**Summary Statistics**			
Adj. R^2 = 0.891		D-W= 2.08		Adj. R^2=0.897		D-W= 1.98	
S.E. of Regression = 0.005		F= 19.9 q=4		S.E. of regression = 0.0161		F= 26.8 q=4	

Note: Standard errors are Newey-West heteroskedastic and autocorrelation consistent standard errors. q stands for the degree of the polynomial.

Table 4. Lag Distribution of SPR1

Lag Distribution of SPR1 (for overall industrial production)				*Lag Distribution of SPR1 (for SMEs)*			
Lags	**Coefficient**	**Std. Error**	**T-Stat**	**Lags**	**Coefficient**	**Std. Error**	**T-Stat**
0	-0.0063	0.0018	-3.5692	0	-0.0063	0.0012	-5.0838
1	-0.0044	0.0011	-4.1196	1	-0.0042	0.0008	-5.0018
2	-0.0028	0.0010	-2.9399	2	-0.0025	0.0008	-3.0741
3	-0.0015	0.0012	-1.2113	3	-0.0011	0.0010	-1.1381
4	-0.0005	0.0015	-0.3038	4	-0.0001	0.0011	-0.0750
5	0.0003	0.0017	0.1708	5	0.0006	0.0012	0.4791
6	0.0007	0.0016	0.4410	6	0.0009	0.0012	0.7449
7	0.0009	0.0015	0.5811	7	0.0008	0.0011	0.7700
8	0.0007	0.0013	0.5608	8	0.0004	0.0009	0.4401
9	0.0003	0.0013	0.2412	9	-0.0004	0.0009	-0.4339
10	-0.0004	0.0016	-0.2612	10	-0.0015	0.0011	-1.3384
11	-0.0014	0.0024	-0.5947	11	-0.0030	0.0017	-1.7653
12	-0.0028	0.0036	-0.7753	12	-0.0048	0.0025	-1.9463
Sum of lags	-0.0172	0.0104	-1.6528	*Sum of lags*	-0.0212	0.0073	-2.9050
Summary Statistics				**Summary Statistics**			
Adj. R^2 = 0.890		D-W= 2.18		Adj. R^2=0.889		D-W= 2.14	
S.E. of Regression = 0.027		F= 19.9 q=2		S.E. of regression = 0.017		F= 27.9 q=2	

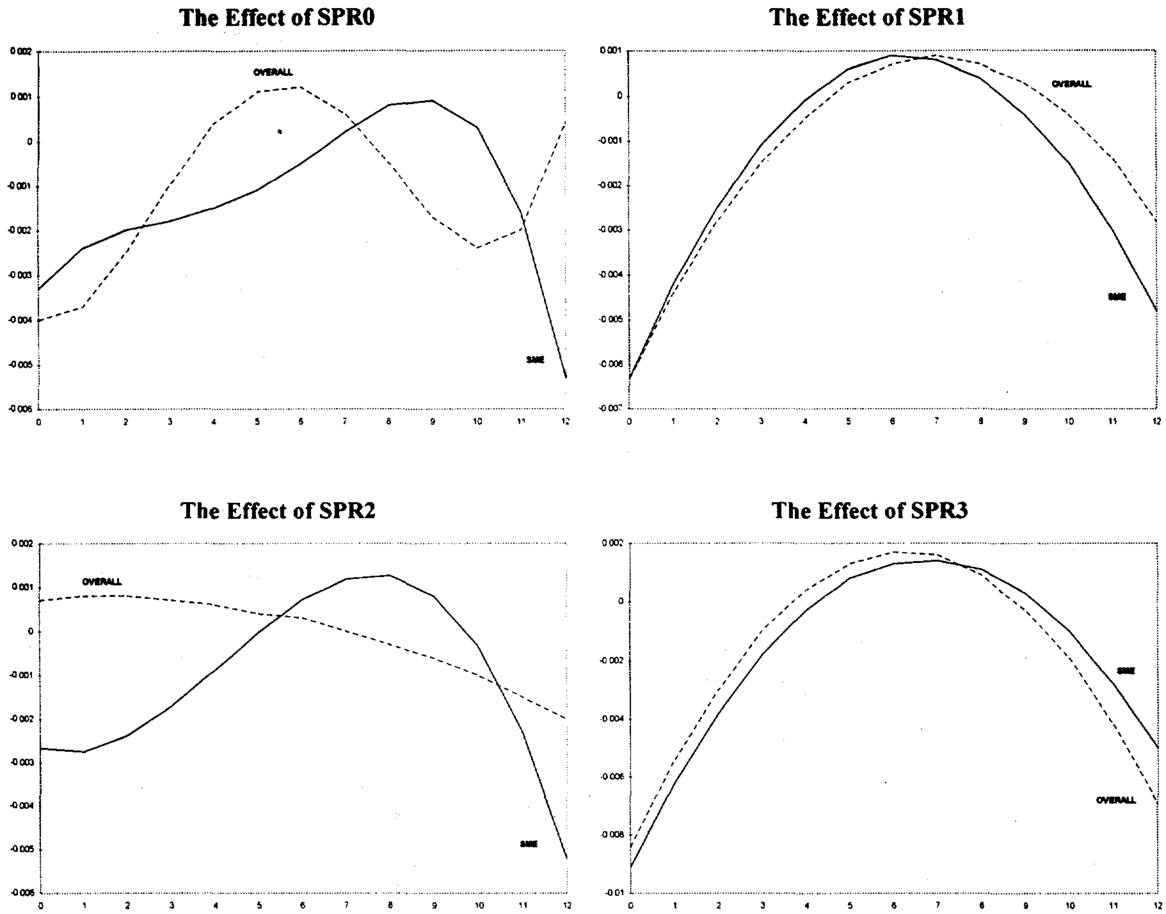
Table 5. Lag Distribution of SPR2

Lag Distribution of SPR2 (for overall industrial production)				*Lag Distribution of SPR2 (for SMEs)*			
Lags	**Coefficient**	**Std. Error**	**T-Stat**	**Lags**	**Coefficient**	**Std. Error**	**T-Stat**
0	0.0007	0.0019	0.3795	0	-0.0027	0.0017	-1.5400
1	0.0008	0.0013	0.5761	1	-0.0027	0.0009	-2.9223
2	0.0008	0.0010	0.7881	2	-0.0024	0.0010	-2.3782
3	0.0007	0.0008	0.8511	3	-0.0017	0.0011	-1.5680
4	0.0006	0.0008	0.7103	4	-0.0009	0.0010	-0.8885
5	0.0004	0.0009	0.5016	5	0.0000	0.0008	-0.0348
6	0.0003	0.0009	0.2752	6	0.0007	0.0007	0.9532
7	0.0000	0.0009	0.0041	7	0.0012	0.0009	1.3477
8	-0.0003	0.0008	-0.3524	8	0.0013	0.0010	1.2230
9	-0.0006	0.0009	-0.7360	9	0.0008	0.0010	0.7691
10	-0.0010	0.0011	-0.9377	10	-0.0003	0.0010	-0.3599
11	-0.0015	0.0015	-0.9478	11	-0.0023	0.0014	-1.6602
12	-0.0020	0.0022	-0.8951	12	-0.0052	0.0028	-1.8585
Sum of lags	-0.0012	0.0097	-0.1207	*Sum of lags*	-0.0143	0.0079	-1.8221
Summary Statistics				**Summary Statistics**			
Adj. R^2 = 0.888		D-W= 2.10		Adj. R^2=0.833		D-W= 1.79	
S.E. of Regression = 0.025		F= 18.8 q=2		S.E. of regression = 0.020		F= 17.4 q=3	

Table 6. Lag Distribution of SPR3

Lag Distribution of SPR3 (for overall industrial production)				*Lag Distribution of SPR3 (for SMEs)*			
Lags	**Coefficient**	**Std. Error**	**T-Stat**	**Lags**	**Coefficient**	**Std. Error**	**T-Stat**
0	-0.0084	0.0029	-2.8999	0	-0.0091	0.0023	-3.9942
1	-0.0054	0.0019	-2.8322	1	-0.0062	0.0015	-4.1611
2	-0.0030	0.0014	-2.1085	2	-0.0038	0.0011	-3.5627
3	-0.0010	0.0014	-0.7265	3	-0.0018	0.0010	-1.7309
4	0.0004	0.0016	0.2463	4	-0.0003	0.0012	-0.2293
5	0.0013	0.0018	0.7208	5	0.0008	0.0013	0.5695
6	0.0017	0.0019	0.9086	6	0.0013	0.0014	0.9657
7	0.0016	0.0018	0.8823	7	0.0014	0.0013	1.0992
8	0.0009	0.0016	0.5780	8	0.0011	0.0012	0.9300
9	-0.0003	0.0015	-0.1736	9	0.0003	0.0011	0.2429
10	-0.0019	0.0017	-1.1551	10	-0.0010	0.0013	-0.8155
11	-0.0042	0.0024	-1.7221	11	-0.0028	0.0019	-1.5085
12	-0.0069	0.0035	-1.9411	12	-0.0050	0.0027	-1.8305
Sum of lags	-0.0252	0.0102	-2.4633	*Sum of lags*	-0.0251	0.0077	-3.2769
Summary Statistics				**Summary Statistics**			
Adj. R^2 = 0.875		D-W= 2.16		Adj. R^2=0.854		D-W= 1.72	
S.E. of Regression = 0.031		F= 18.1 q=2		S.E. of regression = 0.019		F= 22.6 q=2	

Figure 7. The Effects of the Spreads on Industrial Production



The empirical results indicate that SPR0, which captures the overall impact of the credit channel, has a negative and statistically significant effect on industrial production, both overall and for the SMEs, in the long-run. As was expected, SPR0 has a larger impact on SMEs' industrial production. More precisely, a 1 percentage point increase in SPR0 reduces the overall (SMEs') industrial production in the long-run by 1.4 (1.7) percentage points. Similarly, SPR1 and SPR2, reflecting the balance sheet and lending channel effects, have a larger and a statistically more significant effect on SMEs' industrial production compared to that of overall industrial production. An increase in

SPR3, which proxies the slope of the yield curve, also has a negative and statistically significant effect on both the overall and SMEs' industrial production, roughly by equal magnitude.

In sum, the hypothesis that the quantitative impact of an increase in the spread of interest on SMEs' industrial production is greater than that of the overall production is strongly supported. In all cases, except SPR3, the spread in question has a bigger (and statistically significant) impact on SMEs' production than the overall production in the long-run.

5. CONCLUSIONS

The present paper has sought to investigate the impact of monetary/financial shocks on real economic activity as they are magnified through the economy via the credit channel. Our investigation has focused on a country suffering from the fallouts of the Asian crisis, namely Korea, where such adverse effects appear to have undermined economic recovery. In particular, we were concerned with two main issues. First, we wanted to ascertain whether, and to what extent, interest rate spreads capturing credit channel effects could help predict subsequent fluctuations in real economic activity. Within such a context, our second aim was to test whether small and medium-sized enterprises (SMEs) suffer more than other businesses do from the adverse consequences of the credit channel.

The results of our investigation carry implications policy for makers: to what extent should monetary restrictions be used to achieve stabilization after credit channel amplifying effects are factored in and should compensating actions be pursued?

The main conclusion that emerged from our study was that spreads capturing credit channel effects contain significant information for predicting the future course of industrial production in Korea. Moreover, the hypothesis that SMEs suffer more than other businesses do from the adverse effects of the credit channel received strong empirical support. Given the increase in the spread between the bank lending rate and the Government bond rate, triggered by the crisis as well as by the monetary restriction, our results suggest that the decline in industrial production attributable to the magnifying effects of credit channel variables may well be beyond 5 percentage points for the Korean industrial sector as a whole, and even close to 10 percent for SMEs.

We can draw two main policy implications. First, policy makers neglecting credit channel effects might be "overkilling the economy". Second, although further analyses are required to devise proper market-based measures, it might be desirable to provide relief to those particular business segments, such as the SMEs, that unduly suffer from monetary/financial shocks,.

APPENDIX

THE RESULTS OF UNIT ROOT TESTS AND GRANGER CAUSALITY TESTS

Table A.1 Order of Integration: The Results of the Phillips Perron Test

	Level		First Difference	
Variables	without trend	with trend	without trend	with trend
SPR0	-3.84 ***	-4.57 ***	-	-
SPR1	-3.22 **	-3.24 *	-	-
SPR2	-7.20 ***	-7.36 ***	-	-
SPR3	-3.16 **	-4.32 ***	-	-
Y	-1.58	-4.68 **	-11.18 ***	-11.17 ***
Y^{SME}	-1.82	-1.98	-7.58 ***	-7.76 ***
r	-1.75	-1.66	-7.12 ***	-7.34 ***

Note: ***, **, * *indicate rejection of the null hypothesis of a unit root at the 99%, 95%, and 90% significance levels*

Table A.2 The Results of the Granger Causality Tests (SPR0)

Lags	SPR0 → $(Y-Y^T)$	$(Y-Y^T)$ → SPR0	SPR0 → ΔY	ΔY → SPR0
1	0.000253	0.421541	0.003133	0.365248
2	0.001829	0.090765	0.000383	0.370616
3	0.000998	0.193492	0.000161	0.424331
4	0.002823	0.313370	0.000529	0.579989
5	0.006708	0.318166	0.000234	0.618182
6	0.003328	0.327145	0.000427	0.674612
7	0.001909	0.449849	0.001051	0.553018
8	0.002556	0.369487	0.000911	0.503327
9	0.006559	0.454385	0.000721	0.143200
10	0.007157	0.119939	0.003434	0.210829
11	0.010487	0.153437	0.001370	0.176898
12	0.003578	0.067739	0.006081	0.214803

Note: *The numbers in the tables are marginal significance level (p-values) of F Tests for the null of non-Granger causality of the variable in question.*

Table A.3 The Results of the Granger Causality Tests for SMEs (SPR0)

Lags	SPR0 → $(Y^{SME}-Y^T)$	$(Y^{SME}-Y^T)$ → SPR0	SPR0 → ΔY^{SME}	ΔY^{SME} → SPR0
1	0.000007	0.366753	0.000010	0.627567
2	0.000024	0.392168	0.000006	0.610966
3	0.000044	0.525943	0.000007	0.766206
4	0.000129	0.725483	0.000003	0.891177
5	0.000075	0.812896	0.000001	0.935094
6	0.000151	0.874587	0.000008	0.939586
7	0.000580	0.956910	0.000024	0.898938
8	0.001075	0.940003	0.000095	0.895418
9	0.001909	0.906887	0.000066	0.505598
10	0.000468	0.393503	0.004412	0.595184
11	0.044009	0.480604	0.006148	0.206297
12	0.060984	0.299424	0.054698	0.247443

Table A.4 The Results of the Granger Causality Tests (SPR1)

Lags	SPR1 → $(Y-Y^T)$	$(Y-Y^T)$ → SPR1	SPR1 → ΔY	ΔY → SPR1
1	0.005780	0.248298	0.042147	0.711989
2	0.024877	0.261905	0.003750	0.453019
3	0.056635	0.349566	0.009535	0.524120
4	0.014436	0.144809	0.011868	0.498272
5	0.030534	0.215705	0.002888	0.757003
6	0.010924	0.299894	0.001962	0.813900
7	0.008532	0.343769	0.005748	0.721370
8	0.001201	0.353076	0.000285	0.829879
9	0.002264	0.463928	0.000633	0.586192
10	0.007200	0.235026	0.001918	0.671385
11	0.010163	0.243293	0.003827	0.564218
12	0.031551	0.147581	0.026637	0.633301

Table A.5 The Results of Granger Causality Tests for SMEs (SPR1)

Lags	SPR1 → $(Y^{SME}-Y^T)$	$(Y^{SME}-Y^T)$ → SPR1	SPR1 → ΔY^{SME}	ΔY^{SME} → SPR1
1	0.000112	0.706509	0.000153	0.462596
2	0.000032	0.566871	0.000041	0.709466
3	0.000049	0.783469	0.000094	0.875284
4	0.000139	0.660106	0.000004	0.957626
5	0.000124	0.775801	0.000005	0.994724
6	0.000144	0.822484	0.000026	0.998777
7	0.000240	0.919731	0.000030	0.987573
8	0.000083	0.936621	0.000043	0.994052
9	0.000291	0.970070	0.000101	0.644859
10	0.000173	0.503879	0.001799	0.802473
11	0.009629	0.546344	0.001633	0.438422
12	0.000144	0.519688	0.004723	0.455931

Table A.6 The Results of the Granger Causality Tests (SPR2)

Lags	SPR2 → $(Y-Y^T)$	$(Y-Y^T)$ → SPR2	SPR2 → ΔY	ΔY → SPR2
1	0.001496	0.965903	0.005277	0.210301
2	0.000850	0.274793	0.002567	0.465216
3	0.000724	0.359815	0.000168	0.258726
4	0.001996	0.415332	0.002188	0.478551
5	0.009867	0.539080	0.005203	0.602956
6	0.017649	0.608159	0.004880	0.668512
7	0.019662	0.821020	0.010434	0.622101
8	0.020929	0.764570	0.015915	0.457850
9	0.050591	0.736516	0.089655	0.136640
10	0.170212	0.193955	0.201203	0.123481
11	0.184471	0.183160	0.020867	0.093178
12	0.026758	0.195641	0.071143	0.123203

Table A.7 The Results of the Granger Causality Tests for SMEs (SPR2)

Lags	SPR2 → (Y^{SME}-Y^{T})	(Y^{SME}-Y^{T}) → SPR2	SPR2 → ΔY^{SME}	ΔY^{SME} → SPR2
1	0.000145	0.579863	0.000164	0.578399
2	0.000240	0.557261	0.000209	0.549883
3	0.000555	0.510354	0.000264	0.376380
4	0.000993	0.572678	0.001771	0.673984
5	0.003269	0.664652	0.004473	0.740548
6	0.009480	0.779710	0.013335	0.854323
7	0.008636	0.822359	0.020772	0.639255
8	0.015575	0.801752	0.048588	0.743295
9	0.037056	0.880243	0.056224	0.650631
10	0.042257	0.656410	0.152193	0.544198
11	0.256856	0.647512	0.179287	0.461359
12	0.204920	0.675931	0.431166	0.603936

Table A.8 The Results of the Granger Causality Tests (SPR3)

Lags	SPR3 → (Y-Y^{T})	(Y-Y^{T}) → SPR3	SPR3 → ΔY	ΔY → SPR3
1	0.042944	0.071893	0.012664	0.516598
2	0.051770	0.151182	0.037029	0.935513
3	0.079754	0.254931	0.044539	0.982877
4	0.035479	0.172061	0.003816	0.952598
5	0.025042	0.344208	0.000689	0.482929
6	0.019531	0.069168	0.001551	0.108434
7	0.008612	0.005996	0.001265	0.169300
8	0.021526	0.011300	0.002443	0.145584
9	0.026188	0.050115	0.004650	0.122617
10	0.082263	0.096837	0.029021	0.096047
11	0.080841	0.065741	0.041096	0.040503
12	0.227276	0.041363	0.159739	0.037367

Table A.9 The Results of the Granger Causality Tests for SMEs (SPR3)

Lags	SPR3 → (Y^{SME}-Y^{T})	(Y^{SME}-Y^{T}) → SPR3	SPR3 → ΔY^{SME}	ΔY^{SME} → SPR3
1	0.010787	0.084210	0.012664	0.516598
2	0.017383	0.219740	0.037029	0.935513
3	0.093217	0.321485	0.044539	0.982877
4	0.092417	0.360202	0.003816	0.952598
5	0.022819	0.417447	0.000689	0.482929
6	0.018576	0.137477	0.001551	0.108434
7	0.006947	0.067858	0.001265	0.169300
8	0.012963	0.108970	0.002443	0.145584
9	0.024391	0.133442	0.004650	0.122617
10	0.019951	0.069411	0.029021	0.096047
11	0.089579	0.091870	0.041096	0.040503
12	0.296823	0.059305	0.159739	0.037367

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